FACULTY OF MEDICINE AND HEALTH SCIENCES

DEPARTMENT OF BASIC MEDICAL SCIENCES – TISSUE ENGINEERING GROUP

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RANDOM AND ALIGNED PLASMA-ACTIVATED NANOFIBERS OF DIFFERENT DIAMETERS: IMPACT ON CELL MORPHOLOGY AND PROLIFERATION

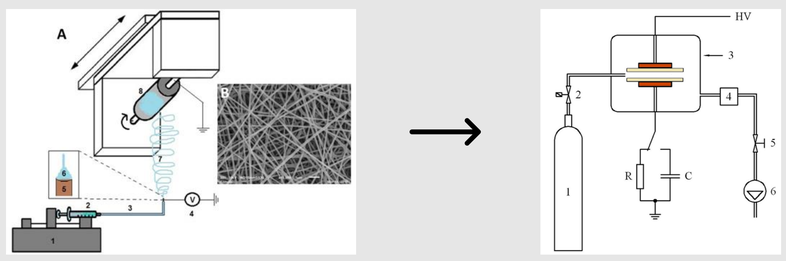
Introduction & Aim

Poly-ε-caprolactone (PCL) is an interesting polymer for tissue engineering purposes due to its good mechanical properties and tunable degradation rate. However, its hydrophobicity raises a big challenge for cell adhesion and proliferation. To overcome this problem, plasma surface treatment could be used. Moreover, surface topography is also described to play an important role in cellular interaction. Therefore, in this study, PCL nanofibers of different diameters and orientations were produced and cellular interaction was evaluated for both untreated and plasma-activated nanofibers.

Methods & Results

Fabrication of nanofibers

PCL nanofibers of different diameters were produced by electrospinning. Both random and aligned nanofibers were produced. Low diameter (+/- 200 nm), medium diameter (+/- 600 nm) and high diameter (+/- 850 nm) nanofibers were further subjected to a argon plasma treatment by using a dielectric barrier discharge at medium pressure.

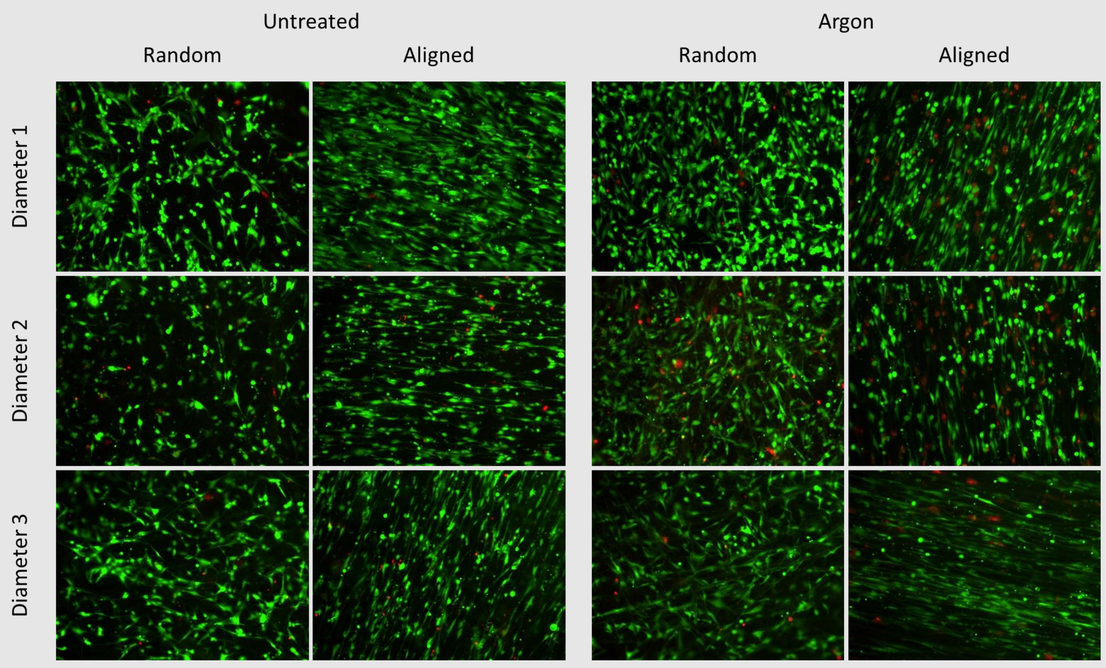


Cell seeding

Adipose-derived stem cells (ADSCs) were isolated from Wistar rats and cultured until passage 3. Cells were seeded at a density of 10 000 cells/sample. Samples were analyzed after 1, 3 and 7 days. Cells cultured on tissue culture plastic (TCP) served as positive control.

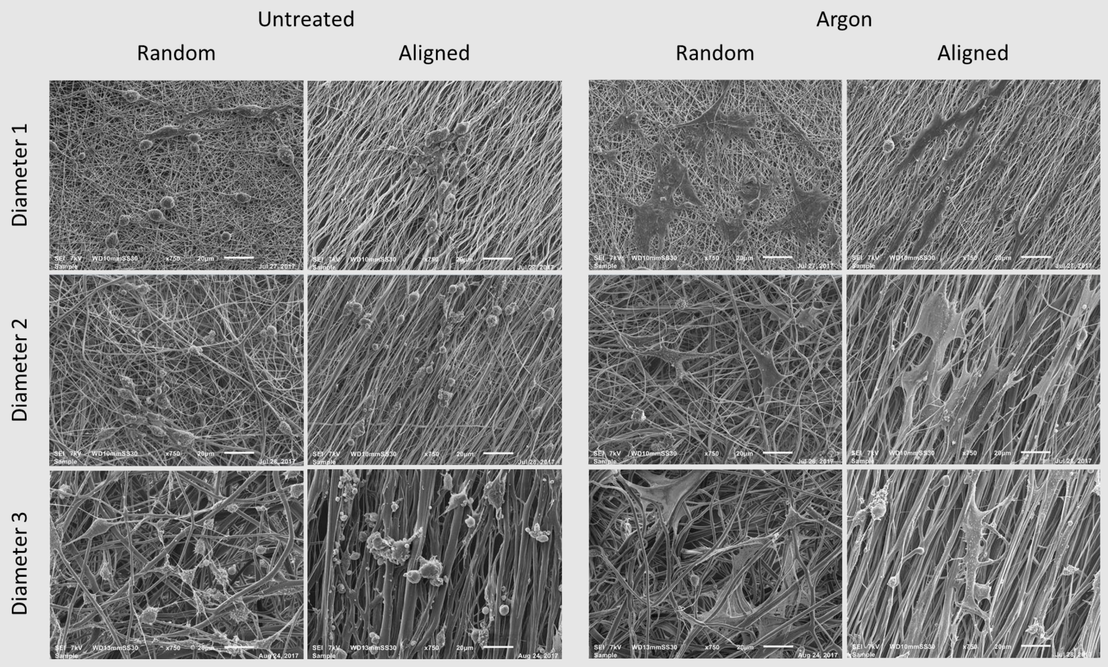
Live/dead assay

Viability of ADSCs was evaluated with a Calceine/PI staining after 7 days. ADSCs remain viable on all samples. However, cell densities seem to differ between untreated and argon plasma treated samples, with the highest cell number on argon plasma treated samples. On aligned nanofibers, ADSCs start to be organized along the orientation of the fibers.



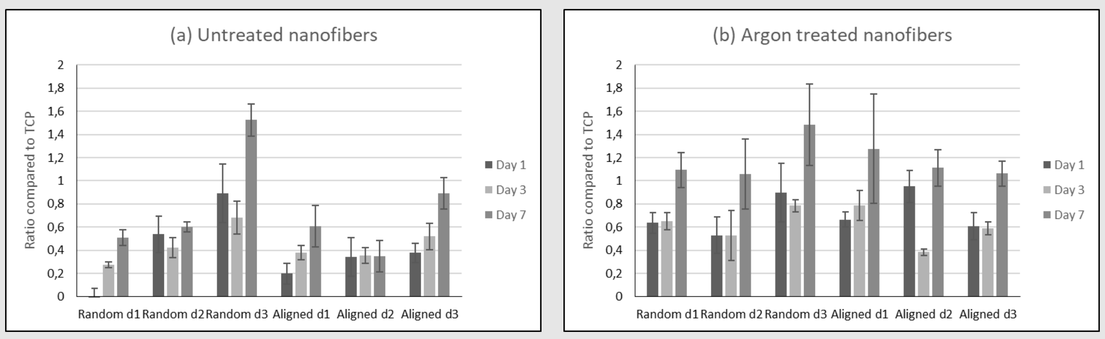
Scanning electron microscopy

Scanning electron microscopy was used to evaluate the morphology of the ADSCs and the interaction with the nanofibers. ADSCs on untreated samples showed a rounded morphology, both on random and aligned nanofibers. On the other hand, ADSCs on argon plasma treated samples showed an irregular, flattened morphology on random nanofibers and an elongated morphology on aligned nanofibers. The higher the diameter of the nanofibers, the more the cells were trapped between the different fibers, especially for the random nanofibers.



MTT assay

MTT assay showed that ADSCs were less proliferative on untreated samples, with ratios under 1 compared to TCP. Interestingly, cell numbers were higher on the nanofibers with the highest diameter. This was not the case for ADSCs cultured on argon plasma treated samples. Cell numbers were similar for all argon plasma treated samples and after 7 days, they even outperformed TCP with ratios above 1. Nanofiber diameter did not seem to have an influence anymore.



Conclusions

To improve cellular interaction of ADSCs with PCL nanofibers, either argon plasma treatment or an increase of surface roughness by using higher diameter nanofibers can be employed, but a combination of both has no synergistic effect. Furthermore, alignment of nanofibers can lead to a distinct organization of ADSCs, with a more elongated morphology and an orientation along the direction of the nanofibers.

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